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GEL HYDRATION TANK AND METHOD

Background

[0001] This invention relates to a gel hydration tank and method for hydrating gels for use in oil and gas well treatment operations.

[0002] Well treatment fluids are often used in oil or gas wells for well completion procedures, to acidify the well formation, and/or increase the recovery of hydrocarbons from the well by creating fractures in the formations, and the like. Many well treatment fluids of this type are composed of water and polymer gel agents and are usually formed by transporting an appropriate polymer gel agent to the well site and mixing it with excess water before the mixture is transferred to a hydration tank. The mixture is introduced into the hydration tank and the finished fluid is withdrawn from the tank on a continuum, yet the mixture must be maintained in the tank an optimum time to allow the polymer gel agent to become hydrated to form a high viscosity well treatment fluid. Thus, the design of the hydration tank is important to ensure the above and thus form an optimum well treatment fluid.

Brief Description of the Drawings

[0003] Fig. 1 is a diagrammatic view of a typical oil well treatment operation incorporating a hydration tank.

[0004] Fig. 2A is a top plan, broken-away, view of a hydration tank according to one embodiment of the present invention.

[0005] Fig. 2B is a side elevational view of the hydration tank of Fig. 2A.

[0006] Figs. 3 and 4 are cross-sectional views taken along the lines 3-3 and 4-4, respectively, of Fig. 2B.

Detailed Description

[0007] Fig. 1 illustrates a typical well treatment operation 10, where a high viscosity well treatment fluid is processed for introduction into subterranean well formations. In the well treatment operation 10, an appropriate polymer gel agent is transported to the well site, and placed in a mixing container 12. The polymer gel agent can include dry polymer additives, stabilized polymer slurries, aqueous liquid gel concentrates, and hydrocarbon-based liquid gel concentrates.

[0008] In the mixing container 12, the polymer gel agent is mixed with excess water and then transferred to a hydration tank 14 to allow time for the polymer gel agent to become hydrated to form a high viscosity well treatment fluid. Although the transformation from a polymer gel agent and water mixture to the resulting hydrated well treatment fluid is on a continuum, for the sake of simplicity the specification will refer to a fluid when it is not necessary to distinguish between the initial polymer gel agent and water mixture and the resulting hydrated well treatment fluid.

[0009] A pump 15 is used to transfer the hydrated fluid from the hydration tank 14 to a blending system 16, whereby sand or another proppant and other liquid additives are accurately metered and mixed with the hydrated gel. Then, another pump 17 transfers the mixture to high pressure pumps 18 that pressurize and transfer the final mixture to the well bore 19. In one embodiment, the well treatment operation 10 produces well treatment fluid substantially continuously. Thus, the hydration tank 14 must permit the flow of the well treatment fluid from the mixing container 12 to the pump 15 at a desired, substantially consistent, flow rate while allowing the fluid to remain in the hydration tank 14 for at least the hydrating period to ensure optimum viscosity for the resulting well

treatment fluid. Thus, to establish an acceptable flow rate and residence time, the fluid should not "finger" ahead and enter the pump 15 before remaining in the hydration tank 14 for the hydration period.

[0010] As shown in Figs. 2A and 2B, the hydration tank 14 according to one embodiment of the present invention includes a set of walls 22, 24, 26, and 28 (wall 28 is removed for clarity in Fig. 2B), extending perpendicular to a floor 30 and attached to the floor 30 in any conventional manner to define a fluid-tight interior portion 32. A top 34 (partially shown in Fig. 2A) may be placed on top of the hydration tank 14 via structural members 36,38 to cover the interior portion 32.

[0011] An inlet pipe 40 extends through the wall 26 and adjacent to the wall 28 for receiving the polymer gel agent and water from the mixing container 12 (Fig. 1) and introducing the fluid into the interior portion 32. Fluid entry is controlled by mixing container 12. An inlet valve 38 is provided for isolating the hydration tank 14 from the mixing container 12. An outlet pipe 46 extends from the interior portion 32 and adjacent to the wall 24 to the exterior of the hydration tank 14 for allowing the discharge of the hydrated well treatment fluid from the hydration tank 14. Fluid exit is controlled by the pump 15. An exit valve 47 is provided for isolating the hydration tank 14 from the blending system 16. Thus, there is a general fluid flow through the interior portion 32 from the inlet pipe 40 to the outlet pipe 46.

[0012] The hydration tank 14 is mobile and includes a base 50 with an attached connector 52 at one end for coupling to a conventional motive source, such as a truck (not depicted). A wheel assembly 54 is attached to the other end of the base 50.

[0013] A plurality of weirs 60-69 are disposed in the interior portion 32 of the hydration tank 14 in a spaced, parallel relation to establish a flow path of the fluid from the inlet pipe 40 to the outlet pipe 46. As shown in Fig. 3, the weir 60 is a flat, plate-like structure having a top 70, a flat side 72, a bottom 74, and a slanted side 76. The top 70 is attached to the structural member 36, which spans between wall 24 and wall 28 and is positioned adjacent to the top 34 of the hydration tank 14. The flat side 72 is

attached to the wall 28, and the bottom 74 is attached to the floor 30. The slanted side 76 is spaced from the wall 24 and creates a specific directional path for fluid to flow.

[0014] The weir 61 is shown in Fig. 4 and is also a flat, plate-like structure having a top 80, a flat side 82, a bottom 84, and a slanted side 86. The top 80 is attached to the structural member 38, which spans between wall 24 and wall 28 and is positioned adjacent to the top 34 of the hydration tank 14. The flat side 82 is attached to the wall 24, and the bottom 84 is attached to the floor 30. The slanted side 86 is spaced away from the wall 28, and creates a specific directional path for fluid to flow. Thus, the weir 61 is substantially similar to the weir 60, but is installed on the laterally opposing wall and is in an inverted orientation relative to the weir 60.

[0015] The weirs 62, 64, 66, and 68 are also connected to the wall 28 and are substantially identical to the weir 60; and the weirs 63, 65, 67, and 69 are also connected to the wall 24 and are substantially identical to the weir 61. Therefore, the weirs 62, 63, 64, 65, 66, 67, 68, and 69 will not be described in detail.

[0016] In operation, the fluid flows from the mixing container 12 (Fig. 1) and into the hydration tank 14 through the inlet pipe 40 (Figs. 2A and 2B), before passing into and through the interior portion 32 of the hydration tank 14 and discharging from the outlet pipe 46. During this flow through the interior portion 32, the fluid is deflected by the weirs 60-69 in a manner to be described, and passes around the weirs 60-69, with each of the weirs 60-69 establishing its own fluid volume movement.

[0017] The general vector for the fluid volume movement for each of the weirs 60-69 is dependent on the above-described spaces between the slanted sides of the weirs and the relevant opposing wall. More particularly, the fluid entering the interior portion 32 of the hydration tank 14 from the inlet pipe 40 initially encounters the weir 60. The fluid volume movement around the weir 60 is shown in Fig. 3 by the reference arrow B₁. The fluid is blocked from passing between the weir 60 and each of the wall 28, the floor 30 and the top 34. Thus, the fluid must flow to the space between the wall 24 and the slanted side 76, generally to the right in Fig. 3. Also, since more fluid volume will pass

through the relatively larger space between the wall 24 and portions of the slanted side 76 closer to the bottom 74, the flow is generally downwardly, as also shown by B₁.

[0018] The fluid next encounters the weir 61 described with reference to Fig. 4. The fluid is blocked from passing between the weir 61 and each of the wall 24, the floor 30 and the top 34. Thus, fluid must flow to the space between the wall 28 and the slanted side 86, generally to the left in Fig. 4 as shown by B₂. Also, since more fluid volume will pass through the relatively larger space between the wall 28 and portions of the slanted side 86 closer to the top 80, the flow is generally upwardly, as also shown by B₂.

[0019] It can be readily appreciated that each weir 60-69 establishes its own fluid volume movement, the even-reference numbered weirs 60, 62, 64, 66, and 68 producing fluid volume movements substantially similar to B₁, and the odd-reference numbered weirs 61, 63, 65, 67, and 69 producing fluid volume movements substantially similar to B₂.

[0020] Thus, the fluid flows in a direction in a horizontal plane of the hydration tank 14 as depicted in Fig. 2A and denoted by the reference arrow H₁; whereas the fluid then flows in another direction in a horizontal plane of the hydration tank 14 as denoted by the reference arrow H₂. The alternate juxtaposition of odd-reference numbered weirs 61, 63, 65, 67, and 69 and even-reference numbered weirs 60, 62, 64, 66, and 68, along the walls 24 and 28, respectively, and the staggered spaced openings, create an alternating pattern of flows H₁ and H₂.

[0021] Also, the fluid flows in a direction in a vertical plane of the hydration tank 14 as depicted in Fig. 2B and denoted by the reference arrow V₁; and in another direction in a vertical plane of the hydration tank 14 as denoted by the reference arrow V₂. As noted above, the alternate juxtaposition of the slanted sides of the odd-reference numbered weirs 61, 63, 65, 67, and 69 and even-reference numbered weirs 60, 62, 64, 66, and 68, create an alternating pattern of flows V₁ and V₂. Thus, the movement of fluid (H₁ and H₂, V₁ and V₂) through the hydration tank 14 in the above manner lengthens the distance traveled by the fluid, thus increasing the residence time to

ensure hydration of the fluid in the hydration tank 14, and allows the use of faster flow rates.

Variations and Equivalents

[0022] It is understood that the number of weirs disposed in the hydration tank 14 is disclosed only for illustrative purposes and that the invention contemplates the use of any number of weirs to create a desired flow rate, the number and size of the weirs being readily calculable based on the hydration tank 14 dimensions and hydrating period. Furthermore, the plug flow efficiency will increase with additional number of weirs, up to a limit.

[0023] Furthermore, it is understood that while the weirs show a slanted side for deflecting the fluid, an embodiment is also contemplated wherein the weirs have straight sides and the walls of the hydration tank 14 are slanted to deflect the fluid. Moreover, although a mobile embodiment of the hydration tank 14 is depicted in the drawings, it is understood that the hydration tank 14 may have various immobile embodiments.

[0024] It is also understood that all spatial references, such as "top", "bottom", "left", "right", "front", "back", "downwardly", "upwardly", "horizontal", and "vertical" are for illustrative purposes only and can be varied within the scope of the invention.

[0025] Furthermore, it is understood that the essential flow patterns shown in the figures and described herein are for example only and the flow patterns may have directions other than horizontal and vertical.

[0026] Although only a few exemplary embodiments of this invention have been described in detail above, those skilled in the art will readily appreciate that many other modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the following claims. For example, small holes may be cut in the bottom of each weir

Year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	